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# "Experimental Study of Automation to Support Time-Critical Replanning Decisions"

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Sponsored by Office of Naval Research

# OVERVIEW:

- Problem Identification
- Experimental Design

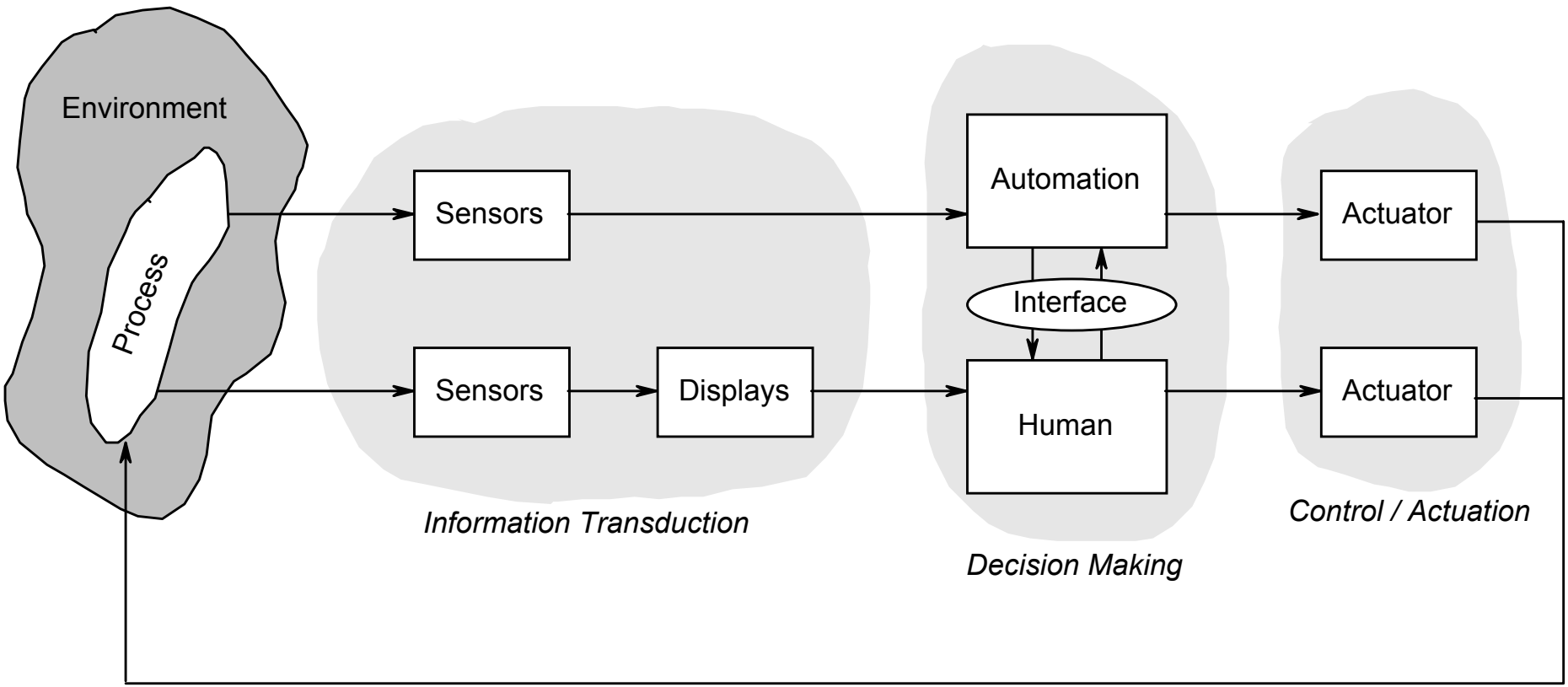
# MOTIVATION:

- **Decision-Making in Complex Environments**
- **Replanning Under Time Pressures**

# PROBLEM UNIQUENESS:

- **Automation will Never "See" Everything**
- **Difficulty in Quantifying a Solution's Value**
  - Unstructured Aspects to Problem
  - Multiple Competing Interests & Goals for Solution

# Human-Automation Interaction in a Decision-Support Task






Adopted from J. Kuchar

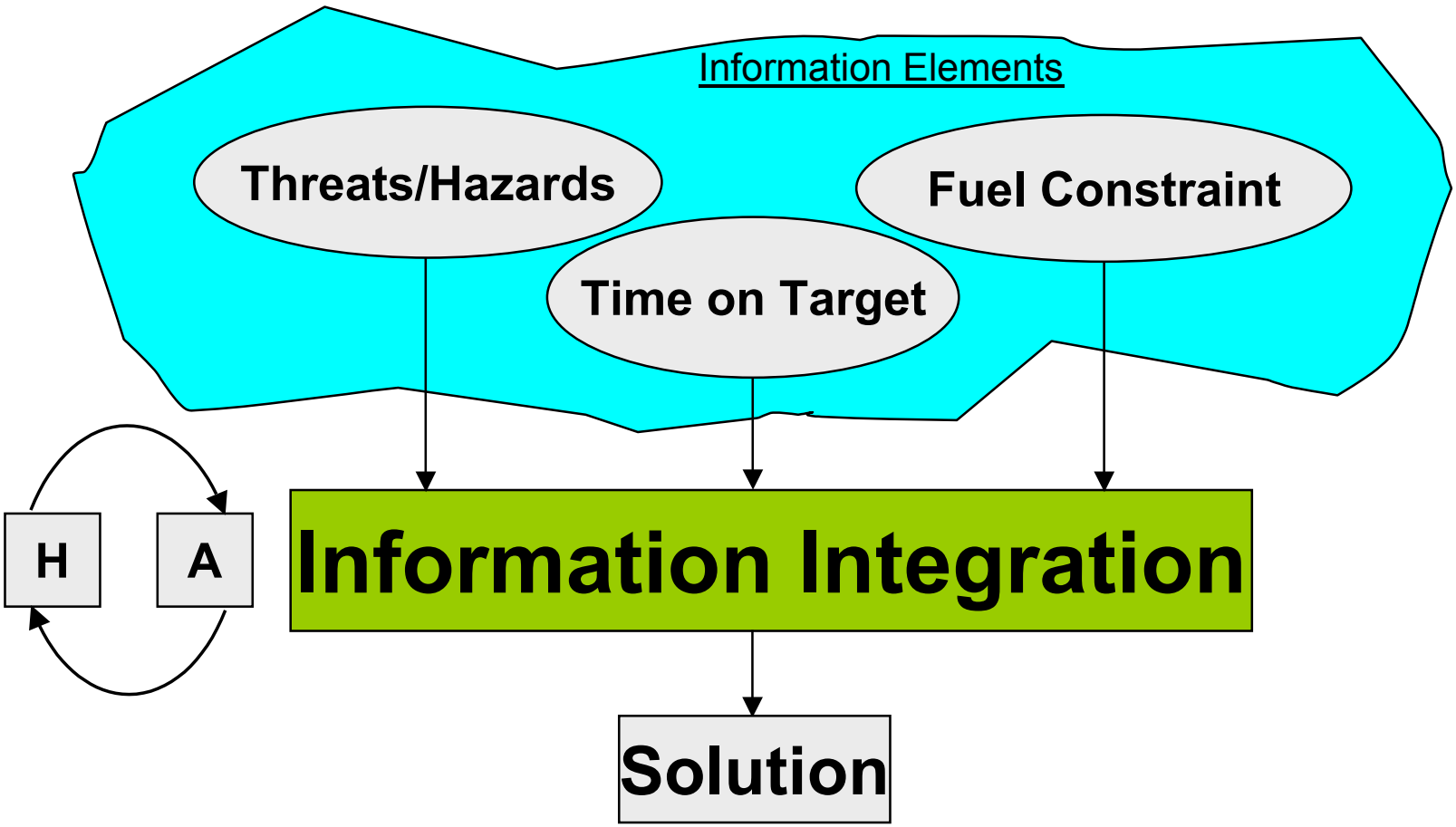
# Example Applications:

- Military Combat
- Aviation
- Medicine
- Chemical and Energy Production
- Finances

➢ **Focus on "Real-Time In-Flight Replanning"**

  ➢ Route Replanning

# Replanning Task Characteristics



# QUESTION?

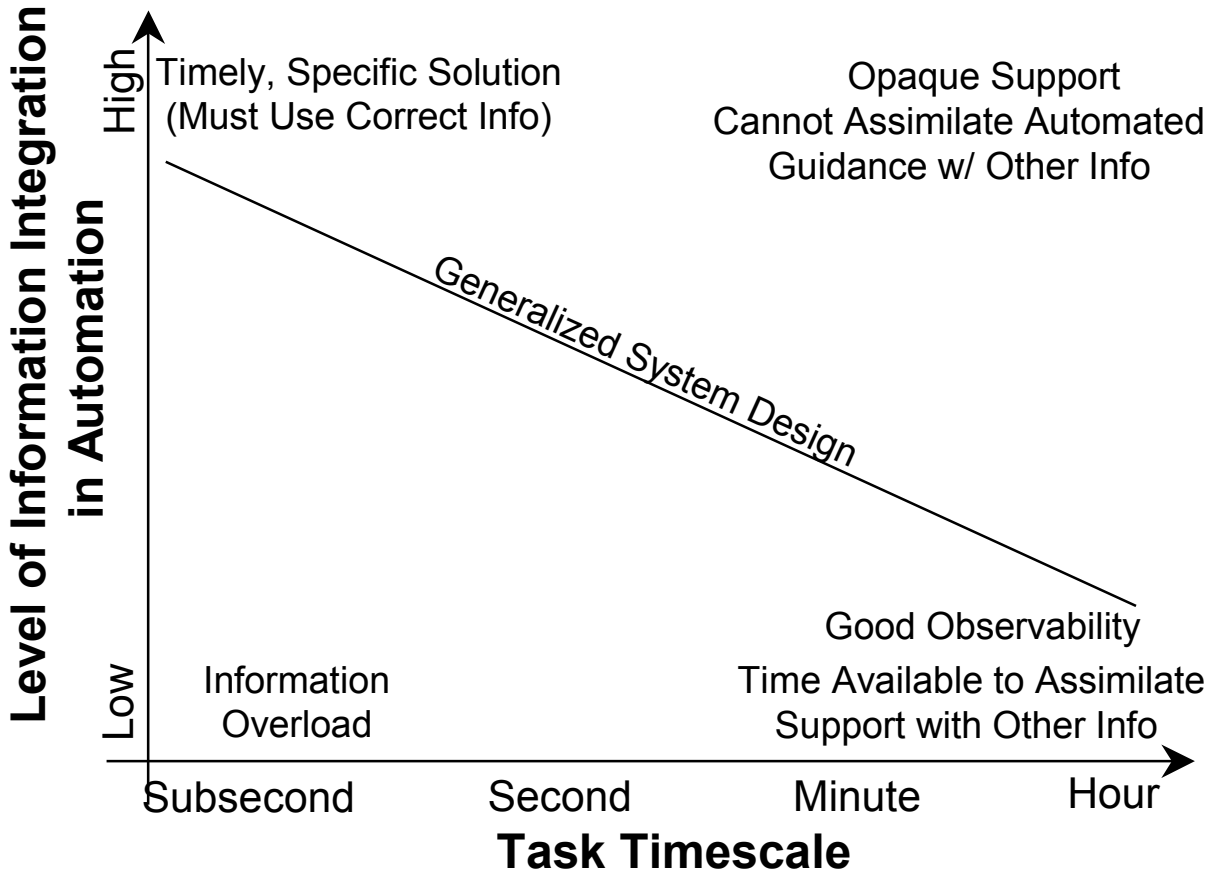
## To What Degree should the Replanner Automation Filter and Integrate Information?

- Take Advantage of Human's Intuition and Ability to Integrate Diverse and Complex Information.
- Replanner Should Have "SMART" Automation Logic Based on Task and Time Pressures.

# HYPOTHESIS:

## As Time Pressure Decreases, More Integrated Automation Support May Hinder Pilot Performance.

# Notional Hypothesis of Interaction Between Information Integration & Task Timescale



# RESEARCH GOALS:

1. Find a Quantifiable Relationship Between:
   - Time Pressures
   - Degree of Information Integration in Automation
   - Resulting Decision Performance

2. Build a Generalized Model of Decision Support Automation.

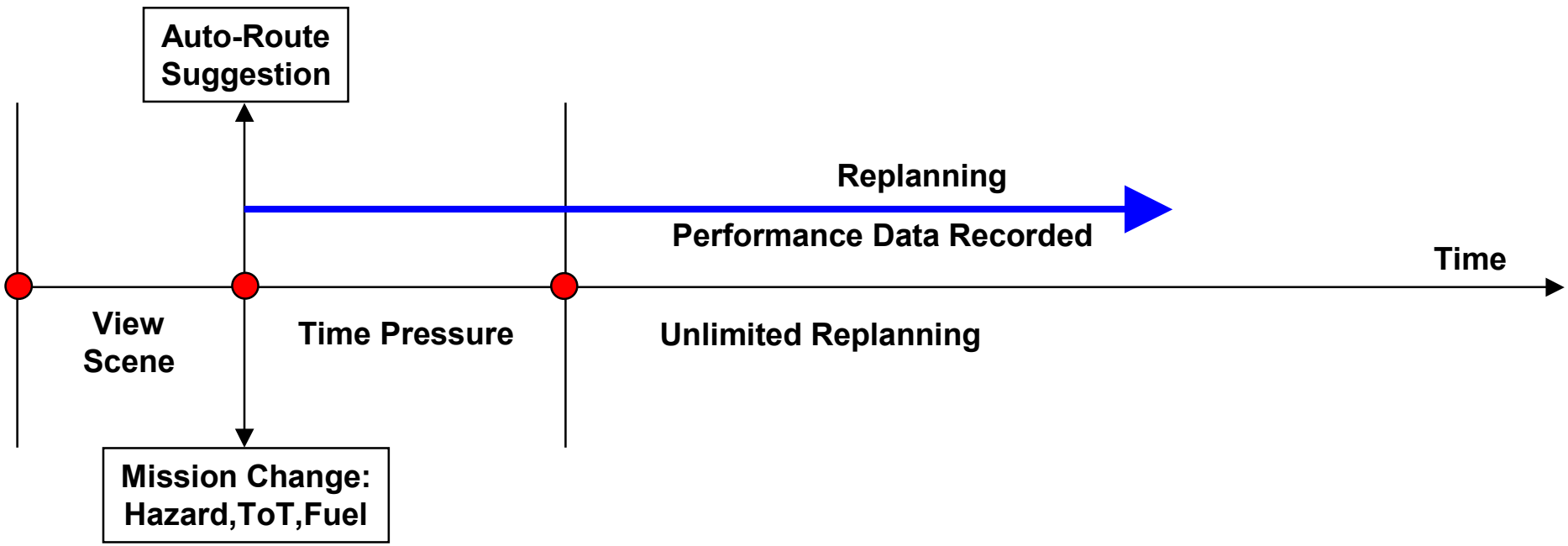
3. Identify Information Support Needs of Human

# EXPERIMENTAL DESIGN:

## Replanning Protocol:

- View Preplanned Mission
- Change in Environment
  - Hazard, Time on Target, or Fuel Update
- Route Suggested with Varying Levels of Information Integration
- Subject Modifies Flight Plan Under Time Pressure
- Minimize Threat Exposure and Time on Target Deviation
- Meet Time on Target and Fuel Constraints

# Sequence of Events



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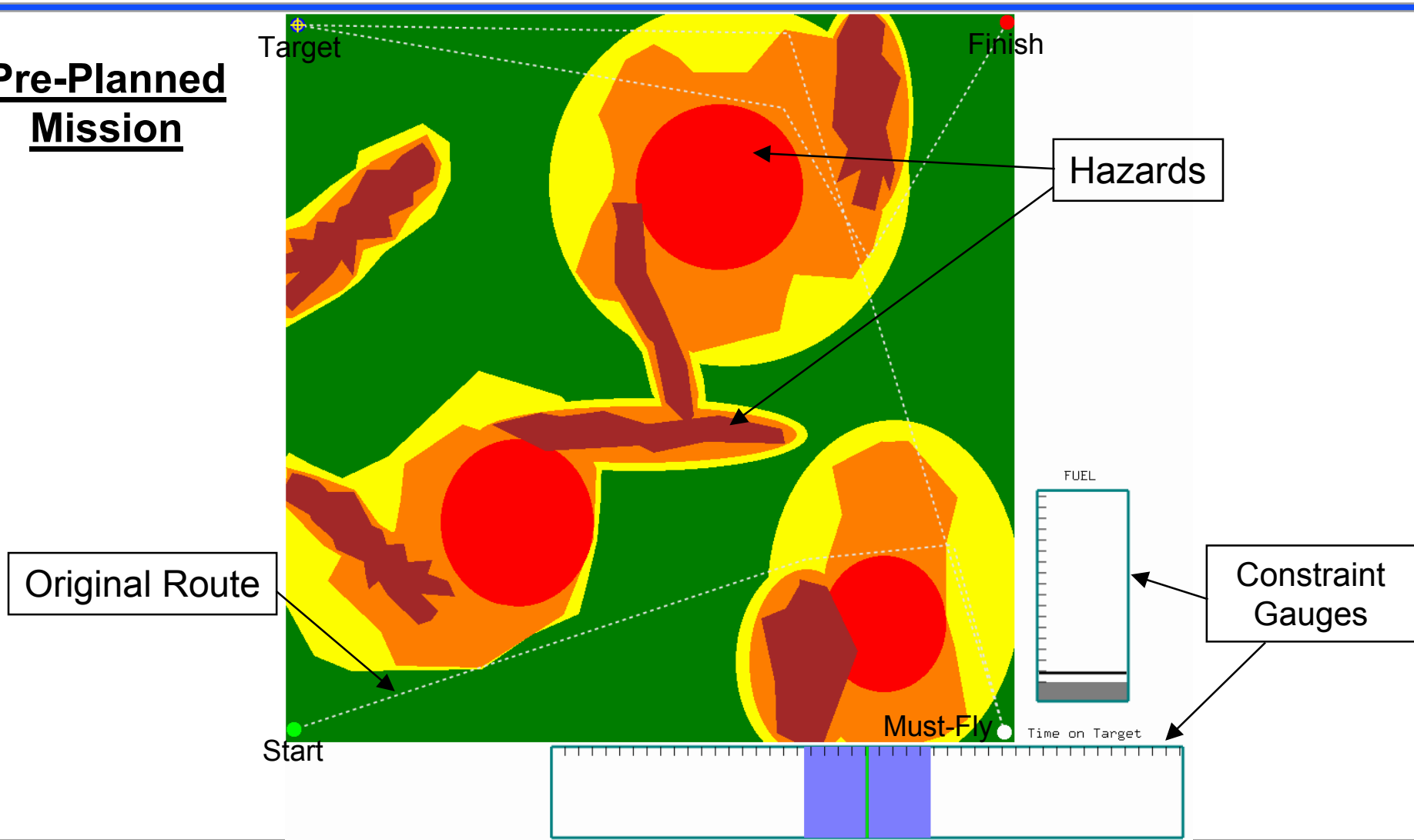
## Pre-Planned Mission



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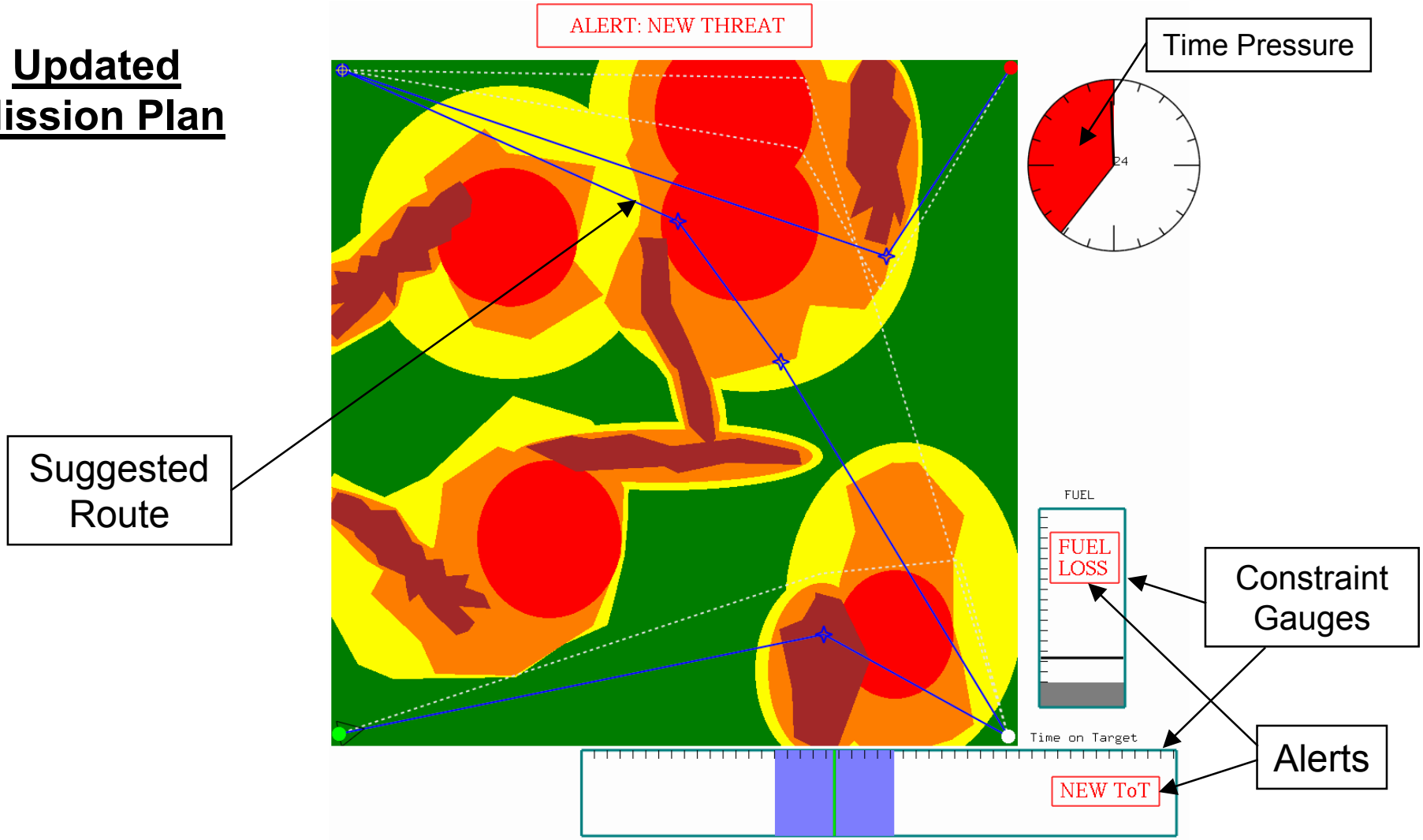
## Updated Mission Plan



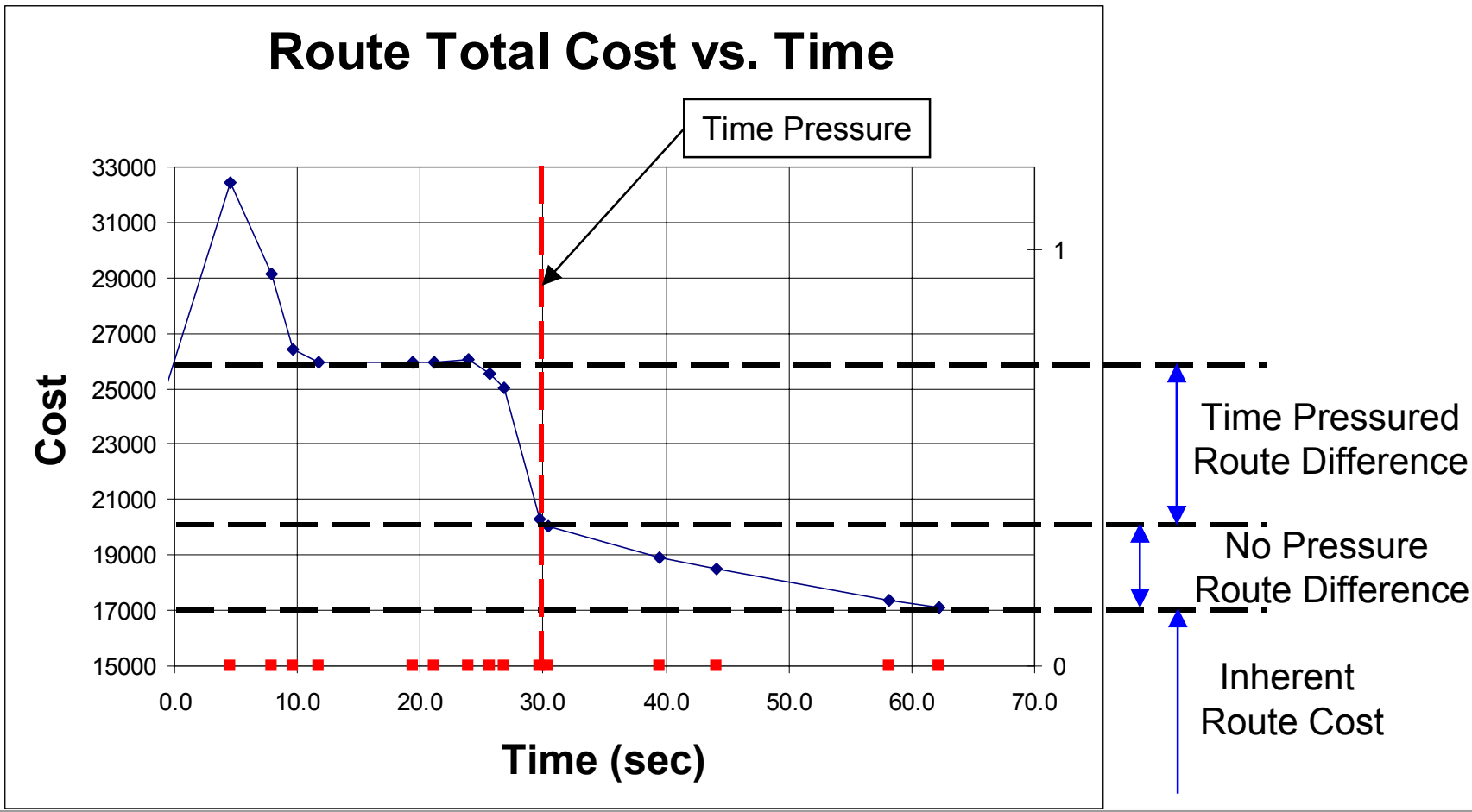
# COST FUNCTION:

$$Cost_{Route} = Cost_{Hazard} + Cost_{ToT}$$

$$Cost_{Route} = A\left[\sum_{Colors}\left(Length_{RouteSegment} * Cost_{Color}\right)\right] + B\left[a_1 * \left(\exp\left(b_1 * \left|\frac{t}{t_0}\right|\right) - 1\right)\right]$$

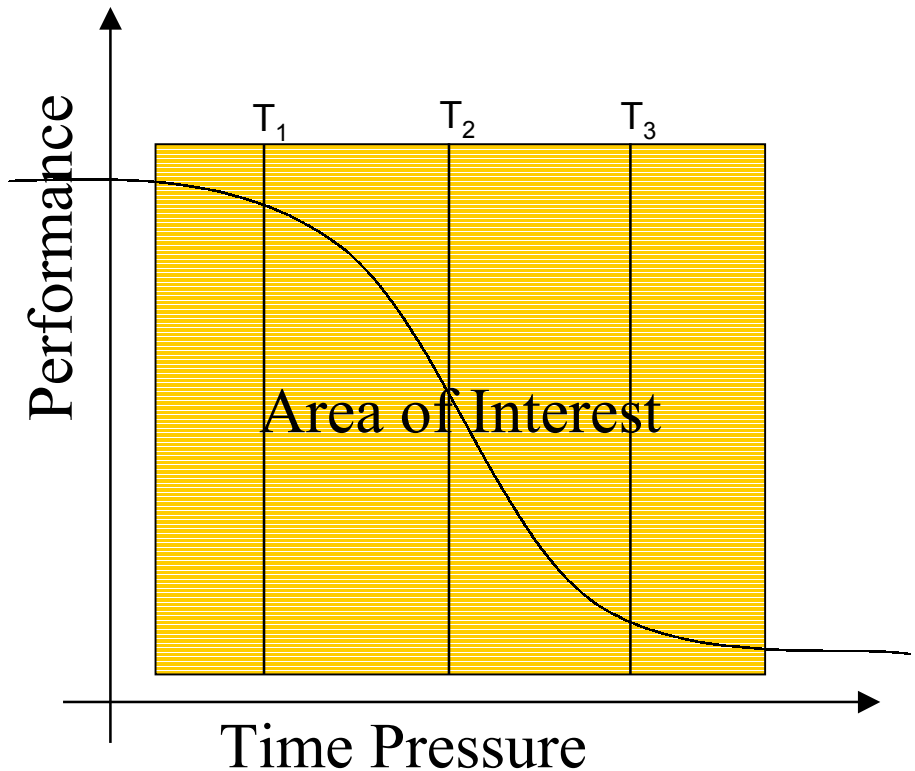
Fuel = Constraint

# Dependent Variable:



# INDEPENDENT VARIABLES:

**Time Pressures (TBD):**



# INDEPENDENT VARIABLES:

## Information Elements Integrated by Automation

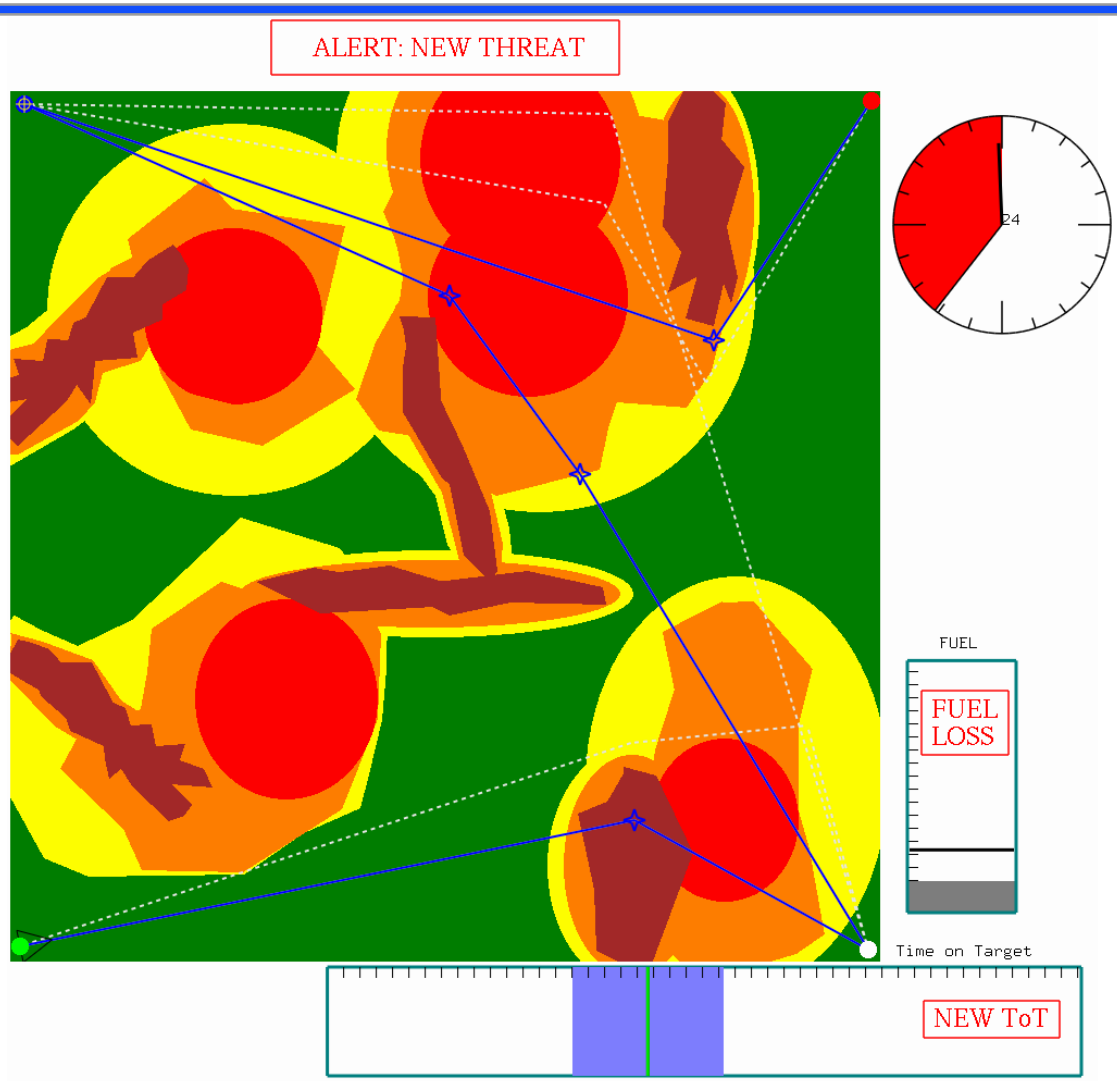
1. No Automation, Manual Replan
   - Original Route Remains

2. Constraint Information Filtration Only
   - Route Modified to Optimize Time on Target Deviation & Satisfice Fuel Constraint

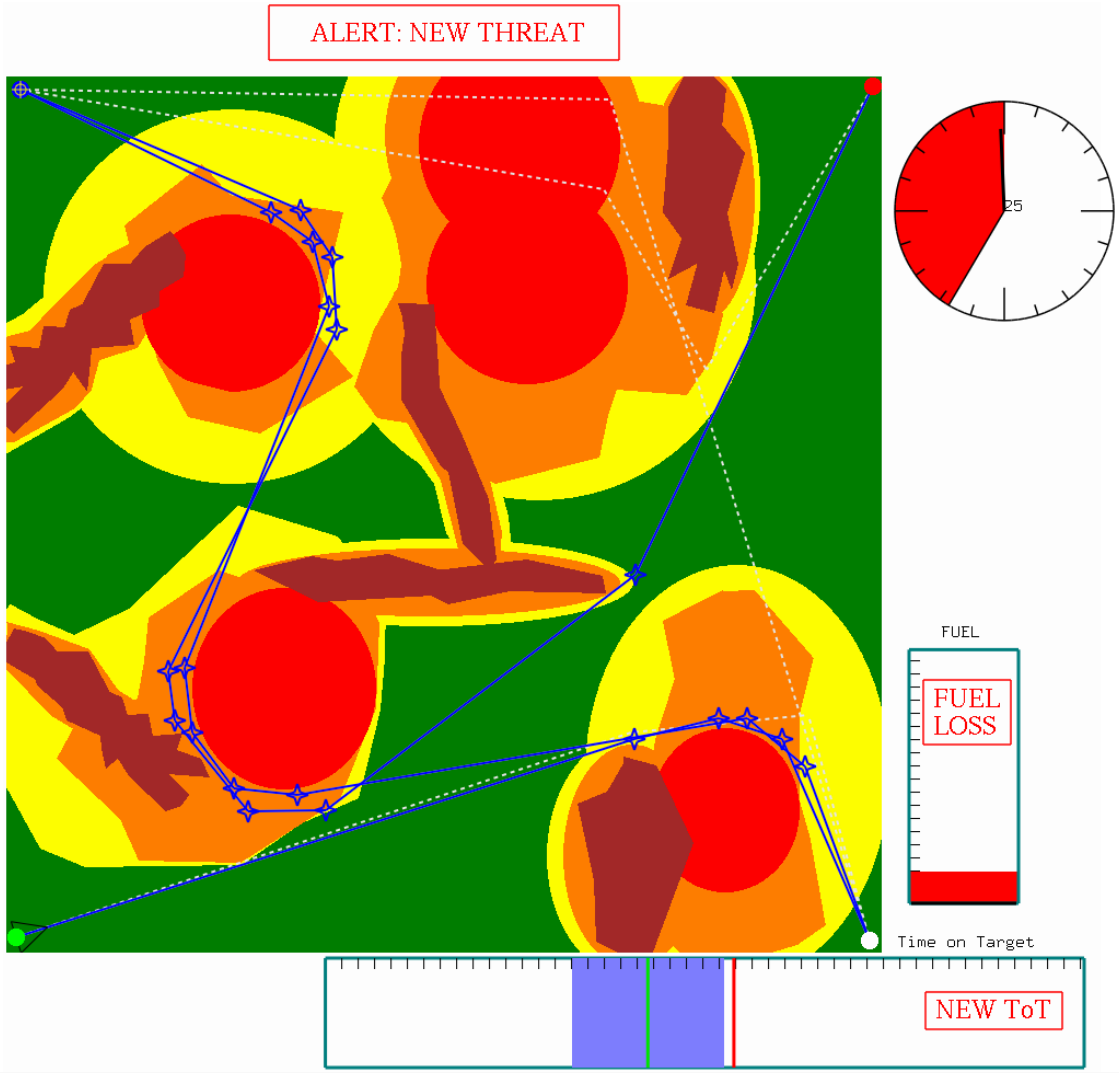
3. Threat Information Filtration Only
   - Route Modified to Avoid/Minimize Hazard Levels

4. Integration of Constraint + Threat Field Information
   - Route Minimizes Threat Exposure + Satifices Time on Target and Fuel Constraints

# Optimize ToT, Meet Fuel Constraint

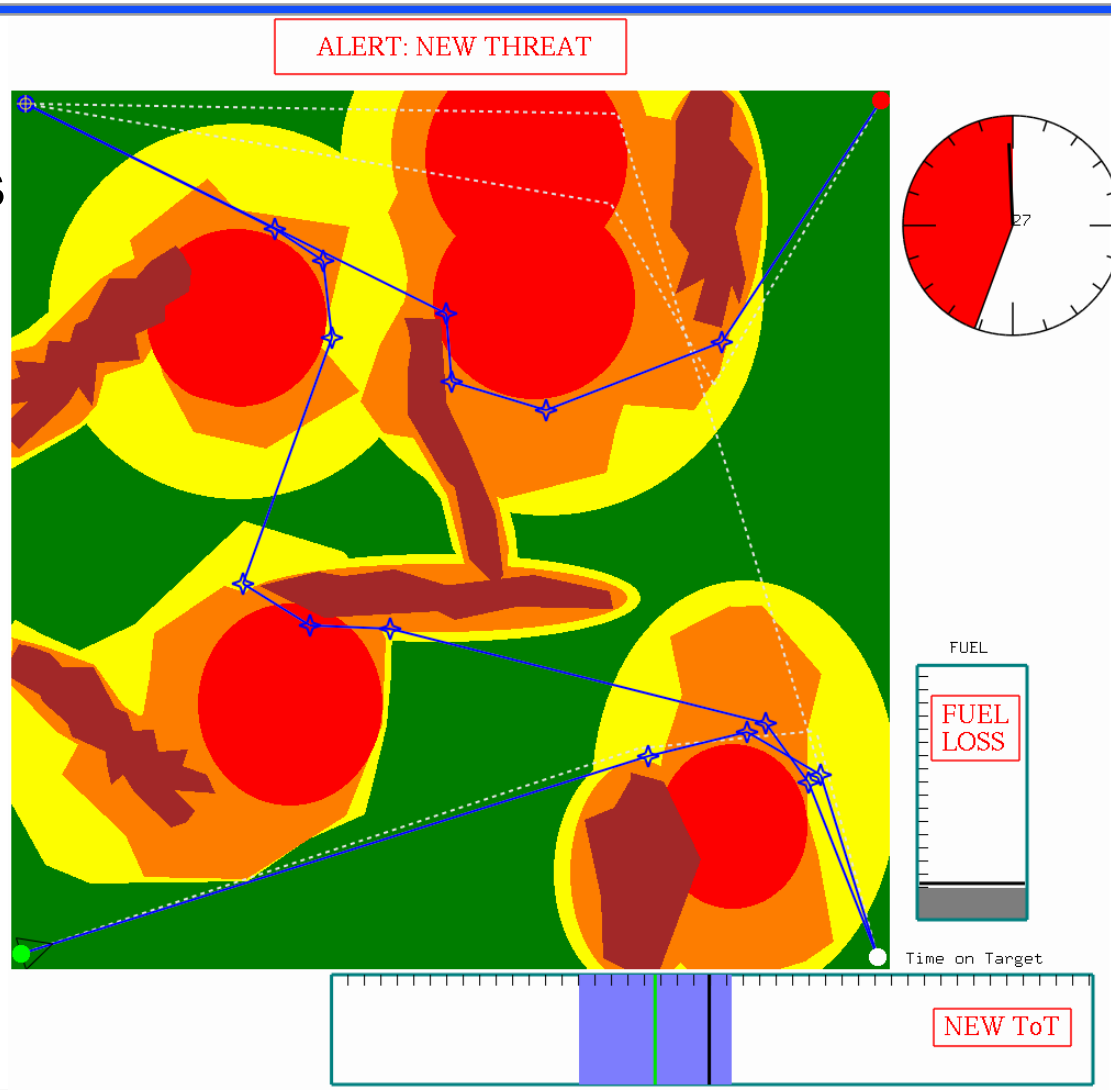


Minimize Threat Exposure



# *"Experimental Study of Automation to Support Time-Critical Replanning Decisions"*

Satisfice Constraints
+
Minimize Threat Exposure



# Experimental Test Matrix

| | | Information Automation | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Time Pressures | a | ● | ● | ● | ● |
| | b | ● | ● | ● | ● |
| | c | ● | ● | ● | ● |

3 by 4 Test Matrix

- Counterbalanced
- Scenarios of Similar Complexity
- Repeated-Measures Analysis of Variance

## Status:

- In-Flight Replanner Software Developed
- Generating Scenarios for Pilot Experiment

## Future:

- Run Data Collection w/ Subjects
- Refine Pilot Experiment for Formal Study


Questions?